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Design and Fabrication of Multi-Utility Spraying UAV

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Abstract

Spraying of pesticides manually causes many side effects to individuals life. The exposure can cause many health effects. In the current study an agriculture drone is designed and fabricated for mapping an agricultural field, spraying pesticides and monitoring crop health. This UAV reduces the time and labor cost. The Agri drone is capable of mapping agricultural field of different terrains and spray pesticides for different kinds of plants as per requirementin autonomous mode via an Agri Assistant software.The UAV is tested for its range & endurance and has a flight time of about 13 minutes. The UAV is also capable of eliminating 90% of pesticides by effective spraying. Such UAVs are useful for various purposes other than agricultural spraying such as mapping and sanitization.

Keywords: *Autonomous Agricultural Drone,Spraying pesticides, Aerial Mapping, Crop health Monitoring.*

1. Introduction

The agricultural industry in India is the most important, accounting for 18 per cent of India's GDP and employing 50 per cent of the country's human labour. Because of faulty methods of monitoring crops, irrigation patterns, and pesticides necessary to be administered, our country is so reliant on agriculture that it has yet to realise its full potential. 60% of the population in India takes agriculture as their occupation. It is the backbone of the Indian economy. It is very important to increase agricultural productivity in the country. According to a WHO (World Health Organization) survey, pesticide poisoning affects over 3 million employees each year, with 18000 people dying as a result. This research intends to reduce the negative effects of pesticides on humans by spraying pesticides over a vast area in a short period of time. This invention is essentially a spraying mechanism mounted on a hexacopter frame. The UAV system is used to spray pesticides and crystal items, and the universal nozzle is used to accomplish so. The aim is to construct an unmanned aerial vehicle (UAV) that can spray huge volumes of pesticides in a short amount of time utilising a hexacopter. The Quadcopter (QC) system, presented by Shilpa Kedari et al [1], is a low-cost and lightweight technology. Unmanned Aerial Vehicle is another name for quadcopter (UAV). These quadcopters are modest in size, and they can be utilised for any crops. This UAV is an android-based autonomous for spraying pesticides and fertiliser. Bluetooth gadget is used to communicate between the quadcopter and the android device in real time. This technique is utilised to alleviate agricultural field difficulties while simultaneously increasing agricultural productivity. S. Sabikan et al [2] used the USP platform to create quadcopter that may be used for any application. Because of their versatility in both hardware and software, project became a success. Sadhana B et al [3] designed a quadcopter UAV with a shower module that may be utilized to for pesticide spraying in crop field to increase production. This project's quadcopter lift has a total payload of 1 kg. For assessing the vegetation, Parth N. Patel et al [6]

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attached cam to the UAV. Y Tanga et al [9] created UAV tested on a 1.2m tall citrus tree, which was separated into six sections and the amount of droplet dropped was also taken into account while evaluating the efficiency. The results show that droplet distributions are uniform.The spraying module consists of a 15L pesticide tank. Vrushabh Mohane et al.[10] created an agricultural UAV that helps farmers save time. The UAV is controlled by an RF-controlled nozzle and is operated manually. The photos will be captured by a multispectral camera to watch their growth, and the edges will be segmented for further research. The remote sensing photos are analysed using the QGIS programme.

In India, traditional pesticide spraying methods are currently used as a result of excessive chemical use, homogeneity, deposition, and coverage of the spray.

2.0 Materials and Methods

To design a hexacopter, one needs to calculate the actual weight of drone, and the weights of all the components are calculated. Understanding the above requirements the battery must be chosen. Then required thrust needs to be analysed along with frame of an UAV with proper dimension.

3.0 Design Consideration

The design was initially based on the diameter of the propeller. A larger propeller could result in a massive increase in the height of the final chassis and an unnecessary increase in the weight of the chassis material. A smaller propeller may reduce chassis height and overall weight, but it must spin up faster to generate the same amount of thrust as a larger propeller at lower speeds. Taking into account all of the disadvantages of a smaller diameter and a larger diameter propeller, we decided to use a propeller of 22 inches with an effective pitch of 8.9inch, resulting in a final output with optimised hover and cruise speeds.

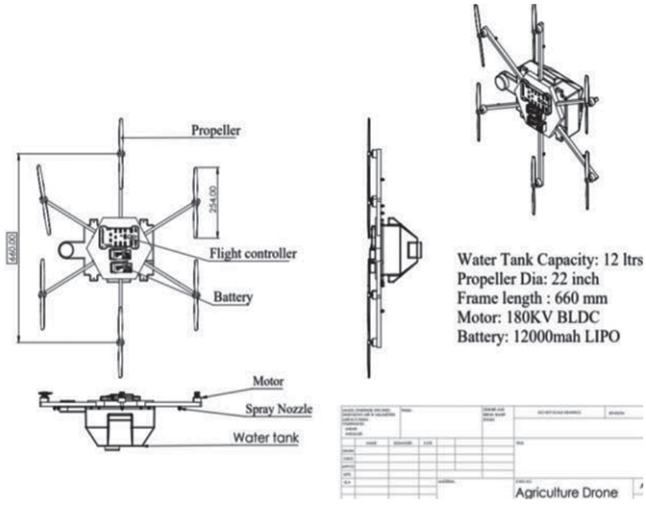

Figure 1: Design of the model

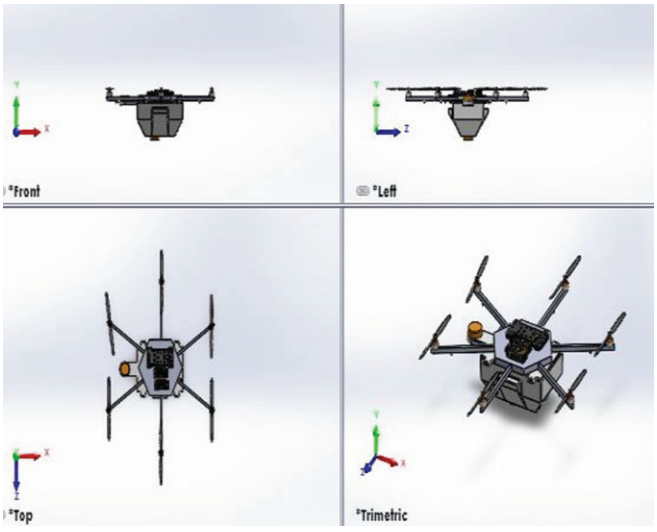

Figure 2: Different views of model

4.0 Electronic components and specification

The hexacopter was chosen for pesticide spraying because it can conduct vertical take-off and landing. multicopters are a type of unmanned aerial vehicle (UAV) that does not require a runway. This capability is critical for spray application. Brushless DC (BLDC) motors are used in multicopter UAVs to create the requisite take-off thrust. The hexacopter is constructed with six brushless DC motors, six light weight 22 inch

Table 1

Specification	Component Specification
Motor	180 kv
Propeller	22inch
Frame Material	Carbon Fibre
Battery	12000 mah
Flight controller	K3-A

propellers, and ESC to produce thrust of 27.62kg. The other electronic components are housed in carbon fibre frame. Pesticide sprayer is mounted at the bottom of carbon fibre frame. A single 16000 mAh Lithium polymer battery powers the complete multicoptor. The lithium polymer battery also provides required power to the operation.

The hexacopter is manually controlled utilising a 8-channel transmitter and receiver operating in the 12-2S. Real time flight data is being received by GCS. Autonomous flights are controlled by flight controller. Carbon fibre tube can be utilised in a variety of projects to replace aluminium or steel tubes. Carbon fibre tubes can be significantly stronger and lighter than aluminium or steel tubes of the same weight. This 20mm roll carbon fibre tube is made of high modulus (T700) unidirectional prepreg carbon fibre that provides maximum strength. The modulus, thermal, and electrical conductivities of carbon fibres produced from pitch can reach 900GPa, 1,000W/mK, and 106 S/m, respectively. Dual gps may give arbitrary polygon route for unregulated terrain, autonomous operation, and enhance work productivity by using a dual GNSS magnetic compass configuration to accomplish the best positioning control, assure safe and stable flying, and provide arbitrary polygon route for unregulated terrain. It has a route memory feature and can compute the spray area, which aids the operator in grasping the dose more precisely. By establishing the A & B Point lines using the remote control, the agriculture sprayers drone will spray in a consistent and efficient route.

5.0 Estimation of the Drone's Payload

A drone's payload is the amount of cargo it can carry the amount of weight it can carry. It is usually counted.separately from the weight of the drone and contains any thing not included in the weight of the drone, like sensors and a spraying system that includes a tank, pump, and nozzle for spraying. The payload that was utilised in a spraying system (12-litre capacity) is included in the design.spraying tank, pump, and nozzle), all of which are used in the application of fertilisers or insecticides on cropsin the fields.

6.0 Thrust calculation

By adding the weights of all the components used in UAV the total weight is estimated.

weight = 25.329kgT = 45.17N, T=45.17/9.8

1 = 4.60Kg, For 6 motors, total thrust is 4.60*6 = 27.62kg. Flight time = 14.22 minutes

7.0 Fabrication of Drone

A hexacopter consists of six arms connected to each motor. The motor is placed over outer end of a carbon fibre frame. On the air frame plate are mounted the battery, highspeed motor support tube, ESC, sensors,

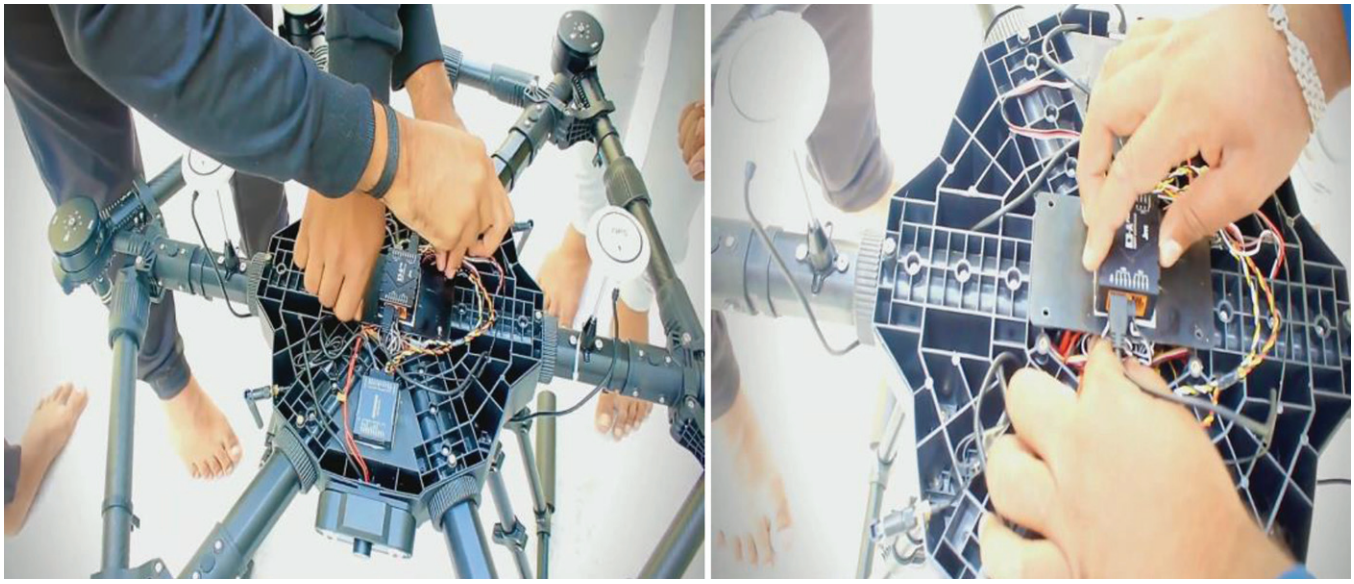

Figure 3: Hexacopter attached with electronic components

Figure 4: Hexacopter attached with tank and pump

Figure 5: Pesticide spraying hexacopter

Figure 6: The hexacopter

circuits. A tank of 12l capacity is mounted at the bottom of frame. Four nozzles are mounted on spray boom. A DC pump is used to generate required pressure for spraying. Two 16000mah lipo battery is used to supply power to all the components. The receiver receives the frequency from transmitter as soon as the sprayer system gets turned on. The transmitter then controls the UAV movement. The process of fabrication of drone is divided into following steps such as

7.1 Fabrication of frame and Electronic Components

7.2 Fixing the Tank and Water Pump

7.3 Final model

8.0 Result and Discussion

Successfully conducted aerial mapping of the agricultural field. Fertilizer and pesticides are sprayed on plants using nozzle accordingly.

Dual battery system is used to add on the endurance. Creating grids based on boundary point marking along with geo co-ordinates for autonomous mode operation.

The following figures are the disease caused plants

As a result of efficient spraying the following are the results of crop.

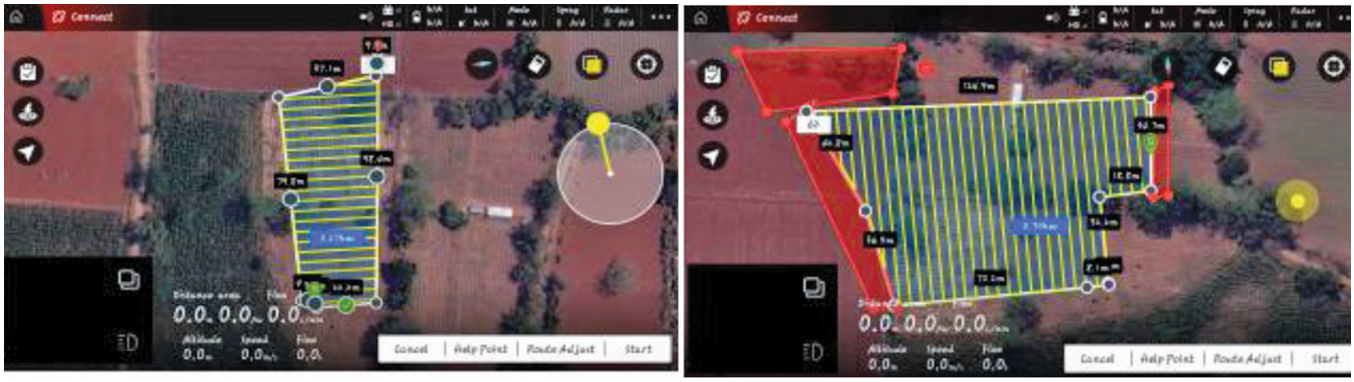

Figure 7: Sugarcane plant post data of grid making (0.85hec), Rosemerry plant postdata of grid making (0.90hec)

Figure 8: Diseased crops

Figure 9: Pests dead after spraying

9.0 Conclusion

The spraying UAV is successfully designed using solid works, developed with all the required components. The developed model is capable of mapping agricultural field and spray accordingly through nozzle with the help of autonomous mode operation. The prototype consists of retractable arms. The sprayer system consist of stabilization unit which plays very important role in removal of external disturbance. The UAV runs with electric power. The UAV has endurance of 14.22 minutes at 16Ah battery pack and practically has 13 minutes on full charge.

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